

Find the square of each number.

- 3 $\rightarrow 9$
- 11 $\rightarrow 121$
- 4 $\rightarrow 16$
- 8.64 $\rightarrow 74.65$
- 6.4 $\rightarrow 40.96$
- 12.5 $\rightarrow 156.25$

Evaluate each expression when $x = 3$.

- $4x^2 - 6 \rightarrow 4(3)^2 - 6 = 30$
- $5x^2 + 8x + 1 \rightarrow 5(3)^2 + 8(3) + 1 = 70$
- $2x^2 + 9x \rightarrow 2(3)^2 + 9(3) = 45$

Read the problem scenario below.

You and your friends are playing soccer in a field by your house. You mark each corner of the field with a flag. Given the distances below, what is the area of your soccer field? Be sure to include the correct units in your answers. Write your answers using a complete sentence.

- The length of the field is 150 feet, and the width is 50 feet.
 $A = l \times w = 150\text{ft} \times 50\text{ft} = 7,500\text{ft}^2$
- The length of the field is 75 yards, and the width is 20 yards.
 1500yds^2
- The length of the field is 80 meters, and the width is 25 meters.
 2000m^2

① $(2, 7), (-3, -3)$
 $\frac{-3 - 7}{-3 - 2} = \frac{-10}{-5} = 2$

② $(-10, -4), (1, 7)$
 $\frac{7 - (-4)}{1 - (-10)} = \frac{11}{11} = 1$ $m = \frac{y_2 - y_1}{x_2 - x_1}$

③ $(0, -7), (-2, 1)$
 $\frac{1 - (-7)}{-2 - 0} = \frac{8}{-2} = -4$

Objectives

In this lesson, you will:

- Graph quadratic functions.
- Identify coefficients in quadratic functions.
- Evaluate quadratic functions.

$Ax + By = C$

Key Terms

- rate of change \rightarrow slope
- quadratic function
- evaluate

linear
 x^2
 $3x$
find the value

SCENARIO Your brother is a graphic artist who works at a company that creates and maintains web sites. One of his jobs is to make art pieces that are put together to form movies (or animations) that are played on different pages of the web site. Each art piece is a frame of the animation. When the frames are displayed one after another, movement can be shown, and the animation is created. His current project is for a web site for a sporting goods company.

Your brother's first job on his current project is to create the frames for an animation of the company logo that will play on the web site's main page. Some of the frames for the animation are shown below. When the frames are displayed one after another, the logo will appear to grow.

The initial side length of the square logo is 1-inch. The side length grows by one-inch in each frame.

A. Complete the table of values that shows the side length of the logo, the area of the logo, and the corresponding frame numbers. Copy the columns of the table into the correct columns in the margins of pages 361 and 362.

Labels	Frame	Length	Area
Units	numbers	inches	square inches
Expressions	x	x	x^2
	1	1	1
	2	2	4
	3	3	9
	4	4	16
	5	5	25

B. How does the length grow as the frame number increases?

How does the area grow as the frame number increases?

Use complete sentences in your answer.

The length grows by one inch as the frame increases by 1.

The area grows by many square inches as the frame ↑ by 1.

C. Find the rate of change in the length and find the rate of change

in the area from the first frame to the second frame. Show all your work and include the units in your answer.

$$\text{Length: } \frac{1-2}{1-2} = \frac{-1}{-1} = 1 \text{ in/frame}$$

$$\text{Area: } \frac{4-1}{2-1} = \frac{3}{1} = 3 \text{ in}^2/\text{frame}$$

D. Find the rate of change in the length and find the rate of change in the area from the second frame to the third frame. Show all your work and include the units in your answer.

$$\text{Length: } 1 \text{ in/frame}$$

$$\text{Area: } 5 \text{ in}^2/\text{frame}$$

E. Find the rate of change in the length and find the rate of change in the area from the third frame to the fourth frame. Show all your work and include the units in your answer.

$$\Delta: 1 \text{ in/frame}$$

$$A: 7 \text{ in}^2/\text{frame}$$

F. Find the rate of change in the length and find the rate of change in the area from the fourth frame to the fifth frame. Show all your work and include the units in your answer.

$$\Delta: 1 \text{ in/frame}$$

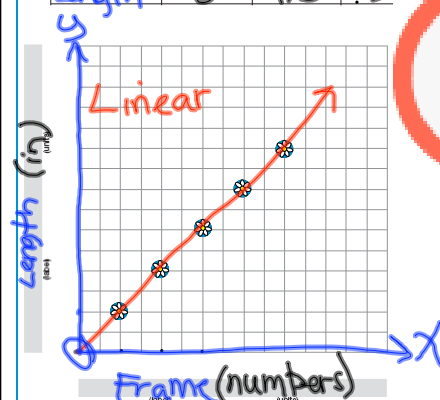
$$A: 9 \text{ in}^2/\text{frame}$$

G. What do you notice about the rates of change in the length with respect to the frame number? What do you notice about the rates of change in the area with respect to the frame area? Use a complete sentence in your answer.

Rates of change for length are the same.

Rates of change for area are different.

Variable quantity	Lower bound	Upper bound	Interval
Frame	0	7.5	.5
Length	0	7.5	.5



Take Note

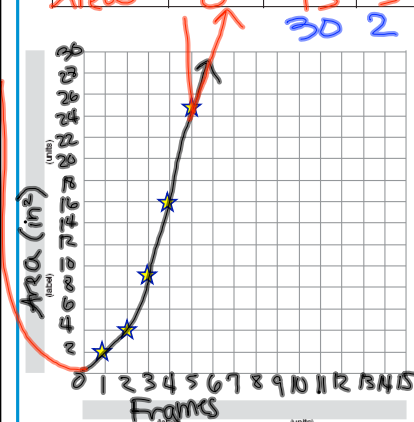
A curve can be a straight line or a curved line.

Investigate Problem 1

2. Draw the curve that best fits the data on your graph in Question 1. Use a complete sentence to describe the shape of your curve.

The best curve is a straight line.

Variable quantity	Lower bound	Upper bound	Interval
Frame	0	15	1
Area	0	75	5



Frame	Area
1	1
2	4
3	9
4	16
5	25

4. Sometimes, the curve that best fits the data is not a straight line.

Draw the curve that best fits the data on your graph in Question 3. Use a complete sentence to describe the shape of your curve.

The curve is shaped like half of a "u".

5. For each graph, write an equation that describes the problem situation. Be sure to define your variables. Write your answers using complete sentences.

$$y = lx + 6$$

$y = x$ Linear

$$y = x^2$$

Quadratic

6. Just the Math: Quadratic Function The equation that you wrote for the area, $y = x^2$, represents the simplest form of a quadratic function. A quadratic function is a function of the form $f(x) = ax^2 + bx + c$, where a , b , and c are constants with $a \neq 0$. The graph of a quadratic function is a U-shaped graph. What can you conclude about the rate of change of a quadratic function? Use a complete sentence in your answer.

The rate of change of a quadratic function is not constant.

7. Identify the values of a , b , and c in each quadratic function below.

$$f(x) = 2x^2 + 3x + 5$$

$$a=2 \quad b=3 \quad c=5$$

$$h(x) = x^2 + 4x - 1$$

$$a=1 \quad b=4 \quad c=-1$$

$$g(x) = x^2 + 4$$

$$a=1 \quad b=0 \quad c=4$$

$$f(x) = -x^2 - 2x + 8$$

$$a=-1 \quad b=-2 \quad c=8$$

$$h(x) = x^2 - 3x$$

$$a=1 \quad b=-3 \quad c=0$$

$$g(x) = 10 - x^2$$

$$a=-1 \quad b=0 \quad c=10$$

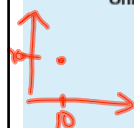
Problem 2 The Bouncing Ball

One of the programmers at your brother's company has the task of making the animations work on the web site. On one of the pages, he has to program an animation of a ball being thrown from one person to another person. The programmer uses a function to determine the path of the ball.

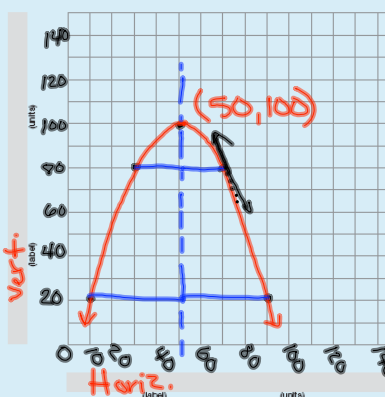


- A. The table below shows some of the positions of the ball on the computer screen with respect to the origin as the animation plays. The origin represents the lower left-hand corner of the screen.

Labels	Horizontal position	Vertical position
Units	pixels	pixels
	10	20
	30	80
	50	100
	70	80
	90	20



Variable quantity	Lower bound	Upper bound	Interval
Horiz. pos	0	150	10
Vert. pos	0	150	10



B. Connect the points with a smooth curve.

C. Find the rates of change in the position of the ball as it moves from position to position. Record the results in the table.

Change in position	Rate of change
from (10, 20) to (30, 80)	$\frac{80-20}{30-10} = \frac{60}{20} = 3$
from (30, 80) to (50, 100)	$\frac{100-80}{50-30} = \frac{20}{20} = 1$
from (50, 100) to (70, 80)	$\frac{80-100}{70-50} = \frac{-20}{20} = -1$
from (70, 80) to (90, 20)	$\frac{20-80}{90-70} = \frac{-60}{20} = -3$

D. What do you notice about the rates of change? Use a complete sentence in your answer.

All different Linear Quadratic

E. What kind of function is represented by your graph? Use a complete sentence in your answer.

Quadratic

Take Note

Order of Operations

- Evaluate expressions inside grouping symbols such as () or [].
- Evaluate powers.
- Multiply and divide from left to right.
- Add and subtract from left to right.

1. The sporting goods company has seen the animation of the ball and wants the two people to be closer together and the ball to be thrown higher. The programmer has come up with a new path that is represented by the function

$$f(x) = -0.05x^2 + 4x + 40.$$

Before you can graph this new path, you need to be able to evaluate this function. Recall that in the order of operations, you should evaluate any powers first. So, to find the value of $f(10)$, substitute 10 for x and evaluate 10^2 first:

$$f(10) = -0.05(10^2) + 4(10) + 40$$

$$= -0.05(100) + 4(10) + 40$$

Then multiply and finally add and subtract from left to right. Show all your work.

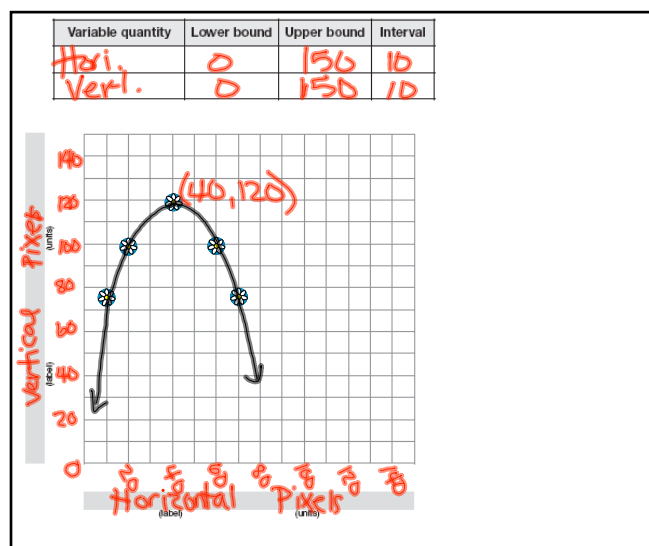
$$= -5 + 40 + 40$$

$$f(10) = 75$$

2. Complete the table below to show some of the new positions of the path of the ball.

$$f(x) = -0.05x^2 + 4x + 40$$

Labels	Horizontal position	Vertical position
Units	pixels	pixels
$x = 10$		75
$x = 20$		100
$x = 40$		120
$x = 60$		100
$x = 70$		75



4. Is the highest point in this graph higher than the highest point in the graph in part (A)? If so, what is the difference in the heights? Write your answer using a complete sentence.

Yes 20 Pixels

5. Evaluate each of the following quadratic functions for the given value of x . Show all your work.

$f(x) = x^2 + 5x + 7; f(4)$
 $f(4) = 4^2 + 5(4) + 7$
 $f(4) = 43$

$g(x) = 25 - x^2; g(-5)$
 $g(-5) = 25 - (-5)^2$
 $g(-5) = 0$

$h(x) = x^2 + 4x - 1; h(-2)$
 $h(-2) = (-2)^2 + 4(-2) - 1$
 $h(-2) = 4 - 8 - 1$
 $h(-2) = -5$

$f(x) = 5x^2 - 18; f(0)$
 $f(0) = 5(0)^2 - 18$
 $f(0) = -18$

$g(x) = 8x^2 - 3x + 10; g(2)$
 $g(2) = 8(2)^2 - 3(2) + 10$
 $g(2) = 32 - 6 + 10$
 $g(2) = 36$

$h(x) = -3x^2 + 15; h(10)$
 $h(10) = -3(10)^2 + 15$
 $h(10) = -300 + 15$
 $h(10) = -285$

6. In Lesson 5.1, you worked with linear functions. What are the similarities between linear functions and quadratic functions? What are the differences? Write your answers using complete sentences.

Similar	Different
for every x only one y -value	Q \rightarrow U-shaped L \rightarrow straight line
Degrees $y = x + 3x$	L \rightarrow constant slope Q \rightarrow not constant "
	Q \rightarrow highest degree/power is 2 L \rightarrow highest " 1.

March 26, 2008

